CLAIMS

1. A method for performing delta volume decomposition and process planning in a turning STEP-NC system, comprising the steps of:

(a) based on a CAD data file including geometry information on a raw stock and a finished part, recognizing a profile of the finished part;

(b) setting a machine configuration of a turning machine based on the recognized profile;

(c) splitting the profile based on the machine configuration;

(d) decomposing a delta volume corresponding to each of the split profiles;

(e) generating a dependency graph based on the decomposed delta volumes, wherein the dependency graph represents operational precedence relations between the decomposed delta volumes;

(f) generating a PSG (process sequence graph) representing a process plan based on the dependency graph;

(g) editing the decomposed delta volumes and/or the PSG; and

(h) generating a part program based on the PSG.

2. The method of claim 1, wherein the step (d) includes the steps of:

(d1) recognizing an inherent delta volume based on information on each of the split profiles;

(d2) updating an input profile by calculating a union of the inherent delta volume and the profile of the finished part;

(d3) based on the input profile, determining a reference line such that a minimum number of monotone chains are obtained based on the reference line;

(d4) determining a maximum monotone chain by connecting the monotone chains; and

(d5) selecting a first turning tool and recognizing a primary delta volume and/or an uncut delta volume based on information on the first turning tool and the maximum monotone chain.

3. The method of claim 2, wherein the step (d2) includes the steps of:

if there are more than one non-monotone segment among the monotone chains, determining a reference line such that the non-monotone segments are monotone to the reference line;

obtaining a maximum monotone chain by connecting the non-monotone segments; and

selecting a second turning tool and recognizing a primary delta volume and/or an uncut delta volume based on information on the second turning tool and the maximum monotone chain.

4. The method of claim 1, wherein the step (e) includes the steps of:

categorizing each of the decomposed delta volumes as one of a primary delta volume, a secondary delta volume and an inherent delta volume, wherein the inherent delta volume is cut after the primary delta volume and/or the secondary delta volume is cut; and

generating the dependency graph based on operational precedence relations between the primary delta volumes, the secondary delta volumes and the inherent delta volumes.

5. The method of claim 4, wherein the dependency graph includes an auxiliary dependency indicating that the inherent delta volume is cut after the secondary delta volume.

6. The method of claim 1, wherein the step (f) includes the steps of:

assigning an operation for a delta volume to each of nodes included in the dependency graph based on the machine configuration; and

setting an operational relation between the operations.

7. The method of claim 6, wherein the operational relation is one of AND, OR and PARALLEL relations, wherein the AND relation represents a non-sequential relation between operations for delta volumes belonging to a node included in the dependency graph, the OR relation represents an auxiliary dependency represented by the dependency graph, and the PARALLEL relation represents a concurrent operation to be performed on a delta volume by using more than two turning tools.

8. The method of claim 1, wherein the turning machine includes a plurality of MUs (machining units) and the method further comprises a step (i) of assigning each of operations represented in the PSG to a corresponding MU.

9. The method of claim 8, wherein the step (i) includes the steps of:

(i1) setting T to zero, wherein T is a current point of time;

(i2) selecting a certain initial setup of the turning machine;

(i3) selecting currently available MUs in the turning machine and adding the selected MUs to $AMU(T)$, wherein $AMU(T)$ is a set of MUs available at a point of time T;

(i4) searching for operations in the PSGs, which are currently executable, and adding the operations to $NOP(T)$, wherein $NOP(T)$ is a set of operations executable at a point of time T;

(i5) based on OSR, selecting an operation OP among the operations belonging to $NOP(T)$, wherein the OSR is a rule for selecting an operation;

(i6) based on *MSR*, selecting an MU *M* among the MUs belonging to *AMU*(*T*) and adding the selected MU *M* to *RMU*(*T*), wherein the *MSR* is a rule for selecting an MU and *RMU*(*T*) is a set of MUs operating at a point of time *T*;

(i7) deleting M from *AMU*(*T*) and deleting OP from *NOP*(*T*);

(i8) if *AMU*(*T*) is not empty, repeating the steps (i3) to (i7);

(i9) if *AMU*(*T*) is empty, adding $\min\{t_j : j \in RMU(\mathrm{T})\}$ to *T*, wherein t_j is time consumed in processing an operation *j*; and

(i10) if all operations are completely processed, terminating the step (i), and if otherwise, repeating to the steps (i4) to (i10).

10. The method of claim 1, further comprising a step (j) of generating a PSG for performing a secondary finish contouring on the finished part based on a tolerance and a surface roughness.

11. The method of claim 10, wherein the step (j) includes steps of:

(j1) determining a significant surface of the finished part;

(j2) selecting a turning tool for each of the surfaces belonging to the sets S_T and S_F, wherein S_T is a set of surfaces related to the tolerance and S_F is a set of surfaces related to the surface roughness;

(j3) assigning to a certain group S_i surfaces to be cut by using same turning tools, wherein S_i is a group including surfaces to be cut by using i turning tools;

(j4) determining an ordered list L_i of operations to be performed on each of the surfaces belonging to set S_i; and

(j5) setting AND relations between the operations belonging to the set L_i.

12. A method for decomposing a delta volume for use in a turning STEP-NC system, comprising the steps of:

(a) splitting a profile of a finished part into N profiles based on a setup and/or a machine configuration, wherein N is a positive integer;

(b) recognizing an inherent delta volume based on information on each of the split profiles;

(c) updating an input profile by calculating a union of the inherent delta volume and the profile of the finished part;

(d) based on the input profile, determining a reference line such that a minimum number of monotone chains are obtained based on the reference line;

(e) determining a maximum monotone chain by connecting the monotone chains; and

(f) selecting a first turning tool and recognizing a primary delta volume and/or an uncut delta volume based on information on the first turning tool and the maximum monotone chain.

13. The method of claim 12, wherein the step (d) includes the steps of:

if there are more than one non-monotone segment among the monotone chains, determining a reference line such that the non-monotone segments are monotone to the reference line;

obtaining a maximum monotone chain by connecting the non-monotone segments; and

selecting a second turning tool and recognizing a primary delta volume and/or an uncut delta volume based on information on the second turning tool and the maximum monotone chain.